

1 **WHAT IS CLAIMED IS:**

2 1. A compact fuel processor for converting a hydrocarbon fuel feed to  
3 hydrogen rich gas, comprising:

4 a cylinder having an inlet end and an outlet end, wherein the cylinder is loaded  
5 with a plurality of catalysts in series fashion thus forming a series of reaction zones; and

6 a heat exchanger having an inlet end and an outlet end, wherein the heat  
7 exchanger is internally positioned through the length of the cylinder so as to provide heat  
8 or remove heat as required by a particular reaction zone.

9 2. The compact fuel processor of claim 1, wherein the plurality of catalysts  
10 comprises autothermal reforming catalyst, desulfurization catalyst, water gas shift  
11 catalyst, and preferential oxidation catalyst.

12 3. The compact fuel processor of claim 2, wherein the heat exchanger is not  
13 positioned within the autothermal reforming catalyst.

14 4. The compact fuel processor of claim 2, wherein the hydrocarbon fuel feed  
15 is preheated by passing through the heat exchanger prior to being introduced to the  
16 cylinder.

17 5. The compact fuel processor of claim 2, wherein the hydrocarbon is  
18 selected from the group consisting of natural gas, gasoline, diesel, fuel oil, propane,  
19 liquefied petroleum, methanol, ethanol, and mixtures of these.

20 6. The compact fuel processor of claim 1, wherein the inlet end of the heat  
21 exchanger is at the outlet end of the cylinder.

22 7. The compact fuel processor of claim 1, wherein the cylinder is oriented  
23 substantially vertically with the outlet end of the cylinder being on top.

24 8. A compact fuel processor for converting a hydrocarbon fuel feed to  
25 hydrogen rich gas, comprising:

26 a reaction chamber

27 a plurality of predefined reaction zones within said reaction chamber, wherein  
28 each reaction zone is characterized by the chemical reaction that takes place within the  
29 reaction zone.; and

30 a heat exchanger having an inlet end and an outlet end, wherein the heat  
31 exchanger is positioned within the reaction chamber.

1           9.     The compact fuel processor of claim 8, wherein a first reaction zone  
2 contains autothermal reforming catalyst, a second reaction zone contains desulfurization  
3 catalyst, a third reaction zone contains water gas shift catalyst, and a reaction zone  
4 module contains preferential oxidation catalyst.

5           10.    The compact fuel processor of claim 9, wherein the heat exchanger is not  
6 positioned within the first reaction zone.

7           11.    The compact fuel processor of claim 8, wherein the hydrocarbon fuel feed  
8 is preheated by passing through the heat exchanger prior to being introduced to the  
9 reaction chamber.

10          12.    The compact fuel processor of claim 8, wherein a mixture of hydrocarbon  
11 fuel feed, air, and water is preheated by passing through the heat exchanger prior to being  
12 introduced to the first reaction zone.

13          13.    The compact fuel processor of claim 9, wherein the inlet end of the heat  
14 exchanger is at the fourth reaction zone and the outlet end is at the second reaction zone.

15          14.    The compact fuel processor of claim 8, wherein each reaction zone of the  
16 plurality of reaction zones may contain one or more catalysts selected from the group  
17 consisting of autothermal reforming catalyst, desulfurization catalyst, water gas shift  
18 catalyst, and preferential oxidation catalyst.

19          15.    The compact fuel processor of claim 14, wherein a reaction zone  
20 containing more than one catalyst is separated from an adjacent reaction zone and is  
21 supported by a permeable plate.

22          16.    The compact fuel processor of claim 15, wherein the plate is selected from  
23 the group consisting of perforated metal, metal screen, metal mesh, sintered metal and  
24 porous ceramic.

25          17.    The compact fuel processor of claim 16, wherein the plate is of a material  
26 selected from the group consisting of inconel, carbon steel, and stainless steel.

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